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Space as a New Sphere of Future Information Warfare

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Abstract

Air power has seen constant development from the Wright Flyer's first flight at Kitty Hawk on December 17, 1903 via the advent of the jet age with the service entry of the Messerschmitt Me 262 in 1942, to today's multi-role fighters (F-35 Joint Strike Fighter) and stealth aircraft (B-2 Spirit multi-role bomber). As a result of this evolution of one hundred years air power has emerged as a central component in power projection. As General William Mitchell said: "Neither armies nor navies can exist unless the air is controlled over them." (Mitchell 1925, xv) We have witnessed a corresponding development in space, albeit with a lag of nearly sixty years. The first satellite, the Sputnik, went in orbit on October 4, 1957 and the first manned spaceflight was accomplished on April 12, 1961 (by Yuri Gagarin). July 20, 1969 saw the first landing of man on the moon by Neil Armstrong; the first Space Shuttle launch was on April 12, 1981; and the International Space Station (ISS) has remained manned since November 2, 2000. Since 1961, more than 400 men and women have visited the realm of space. General Tommy Franks said: "The pieces of this operation (Iraqi Freedom) which have been successful would not have been so without space-based assets ... it's just simply a fact." A major ingredient of success in modern warfare is the capability to collect and analyze information and then use it for the execution of command and control. Intelligence, surveillance, command and control, positioning, and targeting systems along with increasingly technical fire systems will have a key role in this area. Deliberate information warfare operations are conducted during times of crisis and war. They are planned based on information obtained from intelligence and surveillance assets. The aim of the attacker in information operations is to produce a desired effect on targets by means of psychological warfare such as dissemination of information and other psychological operations; by using network attacks and deception along with other forms of information systems warfare; and by employing electronic warfare assets for jamming, and weapons to suppress the enemy's intelligence, surveillance, and command and control systems. Space, the electromagnetic spectrum, virtual networks, the psychological domain, and media will occupy central roles in any future information warfare, and all these can be used in both defensive and offensive modes. The foregoing sums up as a concept of global information warfare. We already have space-based C4ISR, targeting, and positioning systems. The successful execution of operations in future wars depends on the gaining and maintaining of space supremacy. Space is in the process of becoming a new dimension in information warfare.

Keywords: space; information warfare; situational awareness; C4ISR, targeting, and positioning systems

INTRODUCTION

The prevailing notion is that a warfighting party will attempt to achieve a victory by striking targets of critical importance for the enemy on the operational and tactical levels over the entire depth of the battlespace. During the battle, he should be able to maintain momentum, pinpoint the enemy's critical targets, and hit them swiftly, unexpectedly, and with concentrated force. A victory can be obtained by sustaining an operational and tactical tempo higher than that of the opponent. John Boyd's theory of quick transients suggests that to achieve a victory a fighting force must maintain a higher tempo than the enemy. Speed of action is not an end in itself; it is a means of executing command, the aim being to enter inside the opponent's mindset and decision-making process. To enable a leader to execute the observation, orientation, decision, and action phases of the process in an optimized manner, he must develop a sufficiently high level of understanding in a constantly changing environment. (Boyd / Organic Design 1987, 23, Hammond 2001, 123–124, Warden 1989, 6-7, Huhtinen 2005, 70–71)

Ensuring that decision-makers and weapon systems will possess a real-time awareness of events unfolding around them is the most effective way to maintain fighting tempo and tactical freedom of manoeuvring for a warfighting party. An edge over the opponent in situational awareness (SA) makes possible the achievement of information superiority (IS); in other words, a situation in which an operative has been capable of establishing a

position of advantage within an operational environment. In this situation, a party who enjoys information superiority:

on the political level has a better opportunity than any other party to bring forth his own views, constantly promote these views, and get the others convinced about his views.

on the social level enjoys the benefits of an unfaltering will to defend the nation, and of the undisturbed functioning of the society.

on the military level possesses more reliable, more accurate, and more timely information; the party with information superiority will be able to capitalize on his good possibilities of obtaining and utilizing information available to him, and he possesses a timely and accurate picture of the existing situation.

has freedom to operate within an area of operations.

(SIOD 2004, 26)

In information warfare, situational awareness and information superiority can be gained through the utilization of intelligent and networked sensors, command and control systems, and weapon systems. This kind of networked system enables the surveillance of even an extensive battlespace and makes possible the quick and accurate employment of firepower against desired targets.

The humankind of today is essentially a great network where cooperation and communication play a decisive role. This network is sustained by enormous flows of information and energy. This gigantic entity may encompass an infinite amount of information, yet considerable effort and energy is needed to separate useful information from useless; and the more information is available, the harder this will be. (McNeill 2006, 474)

Network centric warfare (NCW) is an operational concept that is applied in information warfare to enable the achievement of information superiority. NCW enhances battle strength through the networking of sensors, decision-makers, and weapons. The aim is to create shared awareness, speed up the process of decision-making and action, to increase lethality, to improve the probability of survival among friendly forces, and to raise the level of self-synchronization in the execution of action and commands. (STAE 2 2004, 177)

The main underlying hypothesis of NCW is that a force capable of building and disseminating a detailed air picture and creating awareness of a commander's decision and then distributing it will be able to raise the battlefield capabilities of the force by virtue of the effects of synchronization. The management of shared information that is prerequisite for decision-making and execution of actions becomes possible when information systems within a shared network are employed. (STAE 2 2004, 296)

The NCW concept should be studied from the perspective of the four domains of warfare and their interactions. These four domains are the physical domain, information domain, cognitive domain, and societal domain.

the physical domain is the location where weapons are employed. The movement and fires of forces take place in this domain, which has three dimensions: terrain, sea (surface and underwater), air, and space. This domain also consists of physical networks, the entire physical reality of a battle area, and the networked strength of network centric warfare. The information domain is where information is created, observations are collected and fused; and where communication and information systems as well as computer data and software applications are located. This domain, using technical solutions, produces a situation picture, forms a background against which the commander creates his or her battle concepts, and serves as the platform for the command and control of warfighters and shooters. On this domain information is collected, processed, disseminated, and stored. The cognitive domain, found in the mindsets of individuals involved in a war, is the realm of ideas, awareness, comprehension, beliefs, and values. It is the domain where a situation picture evolves into comprehension, understanding, and decision-making. The understanding of the commander's battle idea, doctrine, tactics, techniques, and processes takes place within this very domain, which is immaterial and involves leadership, morale, ethics, cohesion between individuals, training and experience (competency), and the effects of media on individuals. The cognitive domain is private; it is personal. The same situation picture and associated information may evolve into entirely different understandings and conclusions in the minds of different persons. The primary objective of network centric warfare in this domain is to improve situational awareness to a level superior to that of the opponent, to distribute it to the forces, and establish a shared understanding of the commander's battle idea, along with a model of synchronization of operations and actions. (Alberts, Garstka, Hayes, Signori, 2001, 12–13)

All operatives are found in the societal domain, which encompasses interactions between organizations and their components, states and coalitions they form, culture, religions, economical system, and governmental and non-governmental operators. This domain comprises an institutionalized array of operations that in turn interacts

with the military sector to a significant extent. In the context of network centric warfare, the social domain translates into the domain of human lives in societies within which various operatives on a number of levels are interlinked via a network. (Smith 2004, STAE 2 177–179)

Man's ability to process the entire flood of information he is faced with is becoming a challenge in information-based warfare as man can only retain and process a limited number of details during a decision-making process. This challenge has given rise to the concept of knowledge warfare, which is based on an idea about the need to process information into a format where man can really use it as driving force, or comprehension. This in turn requires creative developments in the field of information technology. Since man's ability to understand things has limits, "technical understanding" is needed to fuse information and interpret it on a higher level; in other words, presenting information in a format an individual understands and feels more comfortable with.

Information is closely related to the operative decision-making process and it cannot rest solely on socio-technological research. Information is not only a technological problem; it is also a human and cultural problem. Problems are created by decisions that take place through it. More information will not solve the problems; only the right information at right time given to the right people is central. (Huhtinen, Rantapelkonen 2001, 35)

The Finnish Air Force's future Multi Sensor Fusion (MST) system along with an integrated intelligence, surveillance and command and control (iC4ISR) system will, upon completion of their beddown, result in a significant influx of information mass that would be difficult to process and exploit in real time by means of conventional methods solely. In addition, a trend is towards joint systems and cross-border interfaces, and compatible command and control systems, which again requires the utilization of a wide and diverse range of information. The primary challenge here is the massive amount of dispersed information contained in various systems. This in turn necessitates the compilation of information and its subsequent processing into a format that lends to intelligent further interpretations. The solution is information fusion to support the decision-making process of an end user. The related Situation and Threat Assessment (STA) research will lead to the creation of a viable prototype of a joint sensor fusion system based on the seamless utilization of fused sensor information and human comprehension over different branches of the services. STA means first and foremost the assessment of situation and threat posed by an enemy, and it is accomplished using own information and knowledge to process data obtained from surveillance and intelligence assets.

The significance of space as an element of the physical domain is in the ascendancy, especially in information warfare. Space is turning into the main theater of intelligence, surveillance, command and control, targeting, positioning, and communication operations. In the area of weapons employment, precision-guided munitions have emerged in the forefront. During Operation Desert Storm in 1991, of the nearly 230,000 bombs dropped by the Coalition forces 8 percent were precision-guided, and no satellite-guided bombs were used (Klotz 2007). In the Afghanistan war eight years later, 28,000 bombs were dropped; of these, 29 percent were global positioning system (GPS) guided Joint Direct Attack Munitions (JDAMs) (Klotz 2007), while the percentage of smart weapons had risen to 60 percent (Budiansky 2004, 432). The percentage of GPS guided smart bombs had increased to no less than 68 percent in Operation Iraqi Freedom in 2003 (Jokela 2006, Klotz 2007). A space-based positioning system is required for the employment of precision-guided munitions.

REVOLUTION IN MILITARY AFFAIRS IN SPACE

The term Revolution in Military Affairs in Space (RMA), as used in this context, refers to the creation of new technologies for warfighters and command and control purposes. During the past few years, the United States has been particularly active in developing situational awareness technologies. The associated C4ISR systems are becoming space-based to an increasingly larger extent. (Webb, Cyberwar, Netwar... 2006, 82)

The dimensions of warfare have evolved over a long period of time. Until the early 20th century, surface operations were predominant. World War II saw the emergence of operations in the air, under the water, and in the electromagnetic spectrum – which resulted in the significant expansion of battlespace. Radio and radar enabled long-range surveillance and control over distances in the 200-kilometer class.

Due to the inclusion of the air dimension in warfare it now became possible to project air power for simultaneous strikes on several targets far inside the enemy territory using aircraft based deep in the friendly territory, with ease and swiftness that could not be achieved by use of surface forces. Air power could also hit any point in the area held by the opponent, yet within the limitations posed by the capabilities of own air assets, without the need to first decimate the enemy's ground forces. In addition to the utilization of the new dimension *per se*, air power could be used to bolster up surface forces, as manifested by the Germans' *blitzkrieg* tactics. Warfare became unprecedentedly parallel, complex, and high-paced. The appearance of air power in battlespace quickly resulted in the emergence of counter-weapons in the form of fighters for use against ground attack and bomber aircraft, and anti-aircraft artillery and surface-to-air missiles with which all types of aerial targets could be engaged.

The decades that have followed World War II have seen the advent of the information and space dimensions. The former is a cyber dimension in which computers, computer and communication networks, related software applications, and information contained and moving in them merge into a global whole.

The advent of the information dimension is the next step in the evolution process. So far, this dimension has not existed to such an extent as the other dimensions as information has had only very limited availability due to the fact that it has been stored in the brain of individuals and in technical storage media. The digital age has changed all this. Global networks and technologies represent the latest steps in development. Computers, the internet and related technologies, optical fibers, infrared technologies, Bluetooth, satellites, mobile phones, encrypting, technologies, software applications, artificial intelligence, and neuro network technologies all converge and fuse to form the information dimension, a cyberspace, data transmission and information networks with global coverage. A novel feature in this dimension is the combination of technology, man, and virtual reality. Thus, reality has gotten a new essence. (STAE 2 2004, 37–38)

Up until now, space has been used primarily for the basing of C4ISR and positioning systems with civilian applications. The utilization of space is governed by a variety of treaties whose underlying principle is that everyone should have free access to the utilization of space, and space should remain demilitarized.

The Outer Space Treaty principles governing the activities of states in the exploration and use of outer space, including the Moon and other celestial bodies is from January 27, 1967. The substance of the arms control provisions is in Article IV. This article restricts activities in two ways:

- first, it contains an undertaking not to place in orbit around the Earth, install on the Moon or any other celestial body, or otherwise station in outer space, nuclear or any other weapons of mass destruction.
- second, it limits the use of the Moon and other celestial bodies exclusively to peaceful purposes and expressly prohibits their use for establishing military bases, installations, or fortifications; testing weapons of any kind; or conducting military manoeuvres.

The fact that the United States has interpreted the treaty as being applicable only to the putting of weapons of mass destruction in orbit has led towards the increasing use of space for offensive operations. Space-based assets had an important role in combat operations the two Gulf wars, in Kosovo, and in Afghanistan. The United States armed forces use in their various operations observations from weather satellites, links provided by communication satellites, imagery and other observations derived from reconnaissance and surveillance satellites, and position data furnished by positioning satellites. A satellite-based early warning system to provide alerts of missile launches would have been available had it been required. Over one hundred military satellites are available to support the Coalition forces in Iraq. Twenty-seven GPS satellites supply position data for troops and precision-guided munitions while approximately twenty-seven communication satellites provide communication links for command and control. During its February 2000 mission the space shuttle Endeavour generated a three-dimension target map of Iraq. An estimated 33,600 persons in 36 locations worldwide are involved in space-war activities. (Webb/ Cyberwar, Netwar... 2006, 83)

The use of space parallels the use of air. The first use of air was to provide intelligence and reconnaissance information for ground-based weapons (compare Mitchell 1925, 53). The second purpose was to destroy enemy reconnaissance aircraft. The third was the defense of reconnaissance aircraft, by arming them, increasing their agility, and creating a class of aircraft dedicated to fighting other aircraft. The fourth and most important use was to merge the reconnaissance platform with the weapons system by placing explosives on the aircraft. Air-to-ground capability was created. From that point on, control of the air was understood to be a means to dominate the land and sea. This same process is now unfolding in space. Space is already being extensively used for intelligence and reconnaissance. The next phase of space warfare will be an attack on space-based reconnaissance systems, along with attempts to protect these platforms from destruction. Like reconnaissance aircraft were used as platforms for artillery, space satellites give targeting information to earth-based and air-based weapons systems and warfighters. (Friedman 1988, 331)

The next step in the evolution was the building of anti-satellite systems. Development work efforts have focused on anti-satellites (ASAT) and anti-satellite missiles that can be employed to engage an adversary's satellites. A number of different systems have been tested by superpowers over the years. Latest intelligence from United States sources suggests that on January 11, 2007 China conducted a trial in which an obsolete weather satellite was destroyed by a kinetic interceptor carried by a ballistic missile at an altitude of 800 kilometers. (bbc.co.uk, 19.1.2007)

In a trend that has a parallel in the evolution of air power we will see the introduction of space-based weapons systems with space-to-ground capabilities. The first applications in this area are systems designed to engage ballistic missiles. In the longer term, efforts to develop these weapon systems will result in systems that can be used to project both kinetic and non-kinetic firepower to a battlefield. The arrival of these space-bombers will

then, in turn, lead to the emergence of a counter-weapon in the form of the space-fighter – thus, a situation similar to that in airspace will be achieved.

THE DEVELOPMENT OF SPACE-BASED DEFENSE

The Strategic Defense Initiative (SDI) was proposed by the President of the United States Ronald Reagan on March 23, 1983 to use ground-based and space-based systems to protect the United States from attack by strategic nuclear ballistic missiles. The initiative focused on strategic defense rather than the prior strategic offense doctrine of Mutual Assured Destruction (MAD). The plan was to use the Miniature Homing Vehicle (MHV) as a basis for a collection of about 40 space platforms containing up to 1,500 kinetic interceptors. The only successful energy weapon to emerge from the SDI project was the Mid-Infrared Advanced Chemical Laser (MIRACL). This can produce a megawatt of output for around 70 seconds. (Webb/ Cyberwar, Netwar... 2006, 86)

Though it was never fully developed or deployed, the research and technologies of the SDI paved the way for some of the anti-ballistic missile systems of today. The Strategic Defense Initiative Organization (SDIO) was set up in 1984 within the United States Department of Defense to the Strategic Defense Initiative. Under the administration of President Bill Clinton in 1993, its name was changed to the Ballistic Missile Defense Organization (BMDO) and its emphasis was shifted from national missile defense to theater missile defense; from global to regional coverage. BMDO was later renamed the Missile Defense Agency (MDA).

The objective of the National Missile Defense (NMD) program is to develop and maintain the option to deploy a cost-effective, operationally effective and Anti-Ballistic Missile (ABM) Treaty compliant system that will protect the United States against limited ballistic missile threats, including accidental or unauthorized launches or Third World threats. (National Missile Defense News Reports ABM Treaty)

On February 24, 2005 the Missile Defense Agency, testing the Aegis ballistic missile defense system, successfully intercepted a mock enemy missile. This was the first test of an operationally configured standard missile 3 interceptor and the fifth successful test intercept using this system. On November 10, 2005 the USS *Lake Erie* detected, tracked, and destroyed a mock two-stage ballistic missile within two minutes of its launch.

Since 2002 the United States Air Force has fielded and completed the initial integration of land and sea-based interceptors, mobile and fixed sensors, and command, control, battle management and communication systems for the Ballistic Missile Defense System (BMDS). The BMDS has long-range and short-to medium-range defense elements. The long-range system's ground-based interceptors use hit-to-kill technologies to destroy intermediate and long-range ballistic missile warheads in space, in the mid-course phase of flight. The system today will receive a cue from Defense Support Program satellites or from Aegis destroyers. For C2BC activities the system has X-band mobile sea-based radars. For short and medium-range defense Aegis ships have SM-3 interceptors. Patriot Advanced Capability-3 (PAC-3) fire units support Army forces. (MILTECH 8/2007, 28-32)

C4ISR SYSTEMS IN SPACE

The air surveillance systems of the superpowers rely on air-based and space-based radar surveillance systems that use multi-mode radars to build a situation picture based on three-dimensional data of target position. The identification of targets takes place aboard the sensor-carrying aircraft or on another platform using observations provided by passive electromagnetic sensors, by interpreting imagery furnished by image-generating systems, and by utilizing information from other sources. Air-based and space-based platforms secured against attacks by appropriate technical systems or by undertaking necessary actions for their protection. (STAE 2 2004, 298)

The reliance on space for C4ISR systems has one serious disadvantage: space-based satellite systems are extremely vulnerable to attack from anti-satellite (ASAT) systems. The "Commission to Assess United States National Security Space Management and Organization" concluded in January 2001, that the likelihood of attack on United States' space systems needed to be taken seriously to prevent a future "space Pearl Harbor". In fact, the first actual attack on any military satellite system occurred in 2003 when the Iraqi military unsuccessfully attempted to jam the United States GPS. (Webb/ Cyberwar, Netwar... 2006, 84)

Reconnaissance and intelligence satellites have traditionally been almost exclusively utilized by the United States. The uses of these satellites include photographic reconnaissance and signal intelligence, and various measurements. Russia and France have also fielded satellites for photo reconnaissance and signal intelligence. China and Israel launched in orbit a small number of military photo reconnaissance satellites around the turn of the century. Other countries have fielded comparable systems primarily for civilian purposes during the past decade. It is estimated that a total of 113 Western military satellites (excluding Russian and Chinese projects) will be launched by 2013, and 36 of these launches will be made in the United States. The United States will continue to field satellite systems for photo reconnaissance, signal intelligence, and measurement purposes. The

focus will be in the improvement of their all-weather capabilities, coverage, and resolution, as well as in the enhancement of data transmission rates. (STAE 2 2004, 68–69)

Satellite positioning has evolved into a key technique in the employment of precision-guided munitions and real-time targeting. Using precision-guided munitions, warfighters are able to substitute massed fires for desired weapons effect on the tactical and operational levels. Satellite positioning data merged with information from air-based and space-based reconnaissance and intelligence sensors enables the dissemination of real-time targeting data for engaged friendly troops. (STAE 2 2004, 189)

The increasing reliance on satellite positioning for military and non-military purposes will see the development of operational capability, in addition to the GPS, of respective systems developed in the European Union (Galileo), Russia (Glonass), China (Beidou), and India (IRNSS), and maybe others. The aim of these countries is to ensure the availability of positioning data, particularly during crisis, and to provide avenues for their increased commercial use.

A concept that has emerged within the EU is to merge and network national satellites into form a shared system known as European Global Satellite Observation System (EGSOS). The plan is to include in this scheme at least the Helios II (France-Italy-Spain-Belgium), SARLupe (Germany), COSMO-Skymed/Pleiades (Italy-France), and ISHTAT (Spain) (STAE 2 2004, 71, 75)

The United States Air Force's plans to develop space-based sensors to provide a persistent identification and global tracking capability. A small constellation of Space Tracking and Surveillance System (STSS) satellites will enable operation of the missile defense system worldwide, independent of terrestrial-based sensors. USAF will launch two demonstration satellites in November 2007. USAF has on orbit the Near Field Infrared Experiment (NFIRE) satellite to collect high resolution infrared phenomenology data from boosting targets. (MILTECH 8/2007, 33–34)

ENGAGEMENT FROM SPACE

Engagement can be divided into physical engagement and engagement of systems. Physical engagement (kinetic engagement) can be directed to the opponent's physical strength and also to its information-based systems. Engagement of systems is based on non-kinetic forms in order to cause destruction of the opponent's information-based systems to the extent that it prevents the opponent from having situational awareness and thus enabling for itself to produce the needed information superiority.

Space-based systems are becoming a new center of gravity for battlespace. John A. Warden, John Boyd, and Carl von Clausewitz tried in their theories to determine the "center of gravity" which when subjected to effect could help to get the opponent defeated. Clausewitz uses the center of gravity (Schwerpunkt) consistently with its physical meaning for the most part – the balancing point of an object, or the point at which, if all of the object's mass were concentrated there, the Newtonian properties of the object would be unchanged." (Kagan 2006, 107)

John Boyd defined the concept of Schwerpunkt as follows: "Schwerpunkt acts as a center or axis or harmonizing agent that is used to help shape commitment and convey or carry out intent, at all levels from theatre to platoon." (Boyd / Patterns of Conflict, 1987, 78)

John Warden supplements the concept of the center of gravity by "Assaulting the Air Center of Gravity" (Warden 34). Warden continues: "The enemy's air center of gravity may lie in equipment (numbers of planes or missiles); in logistics (the quality and resilience of supply support); in geography (location and number of operational and support facilities); in personnel (numbers and quality of pilots); or in command and control (importance and vulnerability)." (Warden 1989, 34 - 35)

A former director for Space Policy within the Office of the Secretary of Defense outlines the essential "center of gravity" argument: "The contributions of space forces to the success of the U.S. military operations and the importance of space activities to the economy may make the medium for a military and economic "center of gravity" for the nation. A center of gravity is a point of vulnerability where an attack may be decisive for the course and outcome of war. Space has emerged as an area of vital interest to the United States because of its importance to national and economic security." (Berkowitz 2000, 50)

RAND reviewed several distinct classes of space weapons:

- Directed-energy weapons, such as space lasers. They use millions of watts of power and large optics to deliver a speed-of-light knockout punch as a missile arcs over Earth. Depending on the wavelength of the energy beamed out and atmospheric conditions, an energy beam can destroy a target on Earth's surface;

- Kinetic-energy weapons against missile targets. This hardware can ram headlong into a target in space or an object still within the upper reaches of Earth's atmosphere;
- Space-based kinetic energy weapons that slam into targets on the ground, such as large ships, tall buildings, and fuel tanks. Sleek and meteoroid-like in speed, these weapons attack targets at steep, nearly vertical trajectories; and
- Space-based conventional weapons capable of maneuvering to hit terrestrial targets. These can carry and dispense rather exotic packages of destruction, such as radio-frequency or high-power-microwave munitions. (Preston. 2002, Summary xvi-xx)

Space-based weapons present both advantages and challenges. The advantages are:

capability to hit targets not attainable by using other weapons.

space-based weapons are quickly available (from some minutes to some hours) compared with terrestrial weapons systems which are planned to use in the upper atmosphere.

space-based weapons have a long range to targets in space and on the ground

space-based weapons kinetic energy weapons cannot be intercepted because of their very high speed and short penetration time through atmosphere.

The disadvantages are:

space-based weapons are static systems enabling the opponent to focus on these fortification-like targets.

the position of space-based weapons in orbit is predictable.

to introduce kinetic energy and laser weapons in space is expensive in logistics and requires space transportation systems of high performance.

space-based weapons are needed in a great number in order to obtain a sufficient coverage of time and position, for example, for defense of ballistic missiles.

the existing treaties deny locating weapons of mass destruction in space. (The Outer Space Treaty, article IV)

the user of the weapon is responsible for collateral damage caused by the use of space-to-surface weapons (Space Liability Convention, article II) (Preston.. 2002, Summary xx-xxi)

THREE DOCTRINES OF MILITARY USAGE OF SPACE

United States National Space Policy

The United States Air Force has developed and approved a doctrine document outlining the service's approach to warfare in space called Counterspace Operations (AFDD 2-2.1, August 2, 2004). The doctrine details the planning and execution of operations against space systems and satellites, for both defensive and offensive purposes. In effect, the new document establishes as a fact the USAF's intentions not only to weaponize space, but also conduct anti-satellite operations, possibly pre-emptively, against enemy military satellites as well as those with primarily civilian functions and satellites owned and/or operated by third parties.

General John P. Jumper, USAF Chief of Staff says in his foreword: "Counterspace operations are critical to success in modern warfare. The rapid maturation of space capabilities and the evolution of contingency operations have greatly enhanced the effectiveness of air and space power. Combatant commanders leverage space capabilities such as communication; position, navigation, and timing; missile warning; environmental sensing; and reconnaissance to maintain a combat advantage over our adversaries. As demonstrated by the Iraqi deployment of global positioning system (GPS) jammers during Operation Iraqi Freedom, adversaries will target space capabilities in an attempt to deny that combat advantage. We must also be prepared to deprive an adversary of the benefits of space capabilities when American interests and lives are at stake. Space superiority ensures the freedom to operate in the space medium while denying the same to an adversary and, like air superiority, cannot be taken for granted. The development of offensive counterspace capabilities provides combatant commanders with new tools for counterspace operations. Air Force doctrine, likewise, is evolving to reflect technical and operational innovations. Air Force Doctrine Document (AFDD) 2-2.1, the Air Force's first

doctrine publication on counterspace operations, provides operational guidance in the use of air and space power to ensure space superiority.

Space superiority is gained and maintained through counterspace operations, which is one of the Air Force's air and space power functions. Counterspace operations have defensive and offensive elements, both of which depend on robust space situation awareness. These operations may be utilized throughout the spectrum of conflict and may achieve a variety of effects from temporary denial to complete destruction of the adversary's space capability." (Counterspace Operations 2004, 3)

The USAF has filed a futuristic flight plan, one that spells out need for an armada of space weaponry and technology for the near-term and in years to come. The document, called the Transformation Flight Plan 2004, offers a sweeping look at how best to expand America's military space tool kit. The use of space is highlighted throughout the report, with the document stating that space superiority combines the following three capabilities: to protect space assets, to deny adversaries' access to space, and to quickly launch vehicles and operate payloads into space quickly replacing space assets that fail or are damaged or destroyed.

From space global laser engagement, air launched anti-satellite missiles, to space-based radio frequency energy weapons and hypervelocity rod bundles heaved down to Earth from space – the United States Air Force flight plan portrays how valued space operations have become for the warfighter and for protecting the nation from chemical, biological, radiological, nuclear, and high explosive attack.

A number of space-related transformational capabilities are described in the document. While some of these are considered necessary in the near-term (until 2010), others are described as mid-term efforts in 2010-2015, while some efforts are viewed as far-term, beyond 2015. The roster of the Air Force space projects includes the following:

- Air-Launched Anti-Satellite Missile: small air-launched missile capable of intercepting satellites in low Earth orbit and seen as a post-2015 development.
- Counter Satellite Communications System: provides the capability by 2010 to deny and disrupt an adversary's space-based communications and early warning.
- Counter Surveillance and Reconnaissance System: a near-term program to deny, disrupt and degrade an adversary's space-based surveillance and reconnaissance systems.
- Evolutionary Air and Space Global Laser Engagement (EAGLE) Airship Relay Mirrors: significantly extends the range of both the Airborne Laser and Ground-Based Laser by using airborne, terrestrial or space-based lasers in conjunction with space-based relay mirrors to project different laser powers and frequencies to achieve a broad range of effects from illumination to destruction.
- Ground-Based Laser: propagates laser beams through the atmosphere to Low-Earth Orbit satellites to provide a robust, post-2015 defensive and offensive space control capability.
 - Hypervelocity Rod Bundles: provides the capability to strike ground targets anywhere in the world from space.
 - Orbital Deep Space Imager: a mid-term predictive, near-real time common operating picture of space to enable space control operations.
 - Orbital Transfer Vehicle: significantly adds flexibility and protection of United States space hardware in the post-2015 term while enabling on-orbit servicing of those assets.
 - Rapid Attack Identification Detection and Reporting System: a family of systems that will provide a near-term capability to automatically identify when a space system is under attack.
 - Space-Based Radio Frequency Energy Weapon: a far-term constellation of satellites containing high-power radio-frequency transmitters that possess the capability to disrupt, destroy, or disable a wide variety of electronics and national-level command and control systems. It would typically be used as a non-kinetic anti-satellite weapon.
 - Space-Based Space Surveillance System: a near-term constellation of optical sensing satellites to track and identify space forces in deep space to enable offensive and defensive counterspace operations. (Leonard, 2004)

The President of the United States authorized a new National Space Policy on August 31, 2006 that establishes an overarching national policy that governs the conduct of the United States space activities. In outline it says: "The United States will: preserve its rights, capabilities, and freedom of action in space, dissuade or deter others from either impending those rights or developing capabilities intended to do so; take those actions necessary to

protect its space capabilities; response to interference; and deny, if necessary, adversaries the use of space capabilities hostile to U.S. national interests.” One of the fundamental space policy goals is to: “strengthen the nation’s space leadership and ensure that space capabilities are available in time to further U.S. national security, homeland security, and foreign policy objectives”. (U.S. NSP 2006, 1-2)

United States national security is critically dependent upon space capabilities, and this dependence will grow. For national security, homeland security, and foreign policy, the Secretary of Defense shall:

- maintain the capabilities to execute the space support, force enhancement, space control, and force application missions
- establish specific intelligence requirements that can be met by tactical, operational, or national-level intelligence gathering capabilities
- provide, as launch agent for both the defense and intelligence sectors, reliable, affordable, and timely space access for national security purposes
- provide space capabilities to support continuous, global strategic and tactical warning as well as multi-layered and integrated missile defense
- develop capabilities, plans, and options to ensure freedom of action in space, and, if directed, deny such freedom of action to adversaries
- have responsibility for space situational awareness
- establish and implement policies and procedures to protect sensitive information regarding the control, dissemination, and declassification of defense activities related to space. (U.S. NSP 2006, 3-4)

Lieutenant General Frank G. Klotz, Vice Commander Air Force Space Command, described in his speech in the Second International Conference on Space Research on January 31, 2007 the status of the USAF space system: “Next generation space systems, such as Transformational Satellite Communications, and the Space-Based Infrared System will be as different from the U.S. legacy systems as the “Fifth Generation” fighters, the F-22 and F-35, are from the F-15 and F-16. USAF is making important progress in modernizing and recapitalizing every category of satellite and ground-based system.”

In the area of positioning, navigation and timing, GPS is today the worldwide standard. On November 17, 2006 USAF launched the third of the newest generation GPS satellite, the GPS-IIRM. USAF will launch a total of eight spacecraft before they begin launching the follow-on generation GPS-IIF, and USAF already have GPS III on the drawing board. An upgrade included in these next generation satellites is the addition of more civil signals. These civil signals will make GPS less prone to interference and, therefore, more accurate. Each new block comes with increased signal strength and quality, which will ensure GPS is better protected for the users.

Another capability we have invested heavily in is missile warning. In 2007, USAF will launch the last of the legacy Defense Support Program satellites. Meanwhile, the first increment of the next generation of missile warning system, the Space-Based Infrared System, is already on-orbit exceeding expectations. When completely integrated, SBIRS will give greatly increased capabilities to detect and report missile attacks and other infrared events. The program supports several mission areas: including missile warning and missile defense.

Another area of increasing demand lies in wideband communications. To meet this need, in 2007 USAF will launch the first Wideband Global Satellite (WGS) communications system. This one satellite will have more bandwidth capacity than the entire constellation of nine satellites that it is replacing combined. USAF is developing two new constellations to eventually replace the current constellation of five MILSTAR satellites. The Advanced Extremely High Frequency (AEHF) satellite communication system is currently on schedule for launch in early 2008. An 8-by-10 (inch) image that would take two minutes to transmit over the existing MILSTAR satellite will take just 24 seconds with an AEHF satellite. The second constellation is the Transformational Communications Satellite (TSAT) system. The same 8-by-10 image will be transmitted in less than one second over TSAT. TSAT will provide the warfighter with a persistent real-time worldwide connectivity for communications on the move and intelligence, surveillance and reconnaissance assets.“

European Union Space Policy

The space sector is a strategic asset contributing to the independence, security and prosperity of Europe and its role in the world. The space represents a significant element of Europe’s Sustainable Development Strategy and is relevant to the Common Foreign and Security Policy, supporting their goals by providing vital information on critical global issues such on Climate Change and humanitarian aid. The Council emphasizes that all Europe’s space activities contribute to the goals and fully respect the principles set out by the United Nations’ “Outer Space Treaty”, in particular:

- the exploration and use of outer space for the benefit and in the interests of all countries and the recognition of outer space as a province of all mankind
- the use of outer space for exclusively peaceful purposes
- the promotion of international co-operation in the exploration and use of outer space. (Council of the European Union, Resolution on the European Space Policy Annex II, May 25, 2007 2-3)

The space technologies are often common between civilian and defense applications and Europe can, in a user-driven approach, improve coordination between defense and civilian space programs, pursuing in particular the synergies in the domain of security, whilst respecting the specific requirements of both sectors and the independent decision competences and financing schemes. (Council of the European Union, Resolution on the European Space Policy Annex II, May 25, 2007 6)

The European Commission has adopted the European Space Policy, which reflects the key strategic importance that space systems and space applications have for Europe, in order to live up to its global leadership aspirations. This communication marks a milestone for the development of space policy in Europe providing a European identity with space. It is a joint policy document of the European Commission and the Director General of the European Space Agency (ESA). Specifically, the Commission cites ongoing support for the further development and exploitation of European flagship space initiatives such as Galileo and GMES (Global Monitoring for the Environment and Security) and satellite communication applications. Support for technological and scientific advancement will focus on identified critical technology domains, including continued European involvement in the International Space Station (ISS).

The new European Space Policy makes specific reference to defense and security applications, aiming to support increasing synergies between military and civil space programs and, in particular, supporting the interoperability of these systems to ensure investments are maximized. Europe, it says, will also continue to seek autonomous access to space. Today, Europe remains at least partly dependant on the United States and Russia for non-human payloads and completely dependant when it comes to human space missions. Nevertheless, relations with non-European partners will remain a key priority, to include new players such as India and China. The new space policy will provide a specific coordination mechanism for such international cooperation. (European Space Council meeting May 22, 2007 press information)

Overall Space Policy Objective Areas:

- satellite navigation: to secure European independent satellite navigation system
- earth observation: to develop a full-fledged European Earth Observation
- Infrastructure
- satellite communication: to develop advanced satellite communication
- technologies
- security and defense: future national and European development.

(European Commission, 26 April 2007 6)

The council recognizes that the use made by any military users of Galileo or GMES must be consistent with the principle that Galileo and GMES are civil systems under civil control. The vital importance for Europe is to maintain an independent, reliable and cost-effective access to space at affordable conditions. Europe needs to take advantage in a coherent way of the launcher assets under its control. (Council of European Union, 4th Space Council 2007 2-5)

NATO Space Policy

NATO's 1999 Strategic Concept recognizes the need for missile defense to counter nuclear, biological and chemical (NBC) threats. It states, "The Alliance's defense posture against the risks and potential threats of the proliferation of NBC weapons and their means of delivery must continue to be improved, including through work on missile defense. As NATO forces may be called upon to operate beyond NATO's borders, capabilities for dealing with proliferation risks must be flexible, mobile, rapidly deployable and sustainable. Doctrines, planning, and training and exercise policies must also prepare the Alliance to deter and defend against the use of NBC weapons. The aim in doing so will be to further reduce operational vulnerabilities of NATO military forces while maintaining their flexibility and effectiveness despite the presence, threat or use of NBC weapons." (The Alliance's Strategic Concept 1999, article 56)

The Alliance is conducting three missile defense related activities:

- Theater missile Defense (TMD) capability: the Alliance has launched a program for the development by 2010 of the capability to protect deployed troops against short and medium range ballistic missiles by intercepting them in the boost, mid-course and final phases;
- Missile Defense for the protection of NATO territory: NATO also has approved the results of a study to examine options for protecting the Alliance territory, forces and population centers against the full range of missile threats;
- TMD cooperation with Russia: under the auspices of NATO-Russia Council, work is ongoing to create the conditions for NATO and Russia to conduct joint TMD operations during crisis response missions.
(www.nato.int/issues/missile_defense/index.html, August 8, 2007)

NATO's Satcom Post-2000 program gives the Alliance improved satellite communication capabilities, which is important as NATO forces take on expeditionary missions far beyond the Alliance's traditional area of operations. Under the program, the British, French and Italian governments are providing NATO, through what is known as "Capability Provision", with advanced satellite communication capabilities for 15 years as of January 2005. The benefits include increased bandwidth, coverage and expanded capacity for communications and data, to be used by ships at sea, air assets, and troops deployed across the globe. (www.nato.int/issues/satcom/index.html, June 26, 2007)

SUMMARY

Operation Desert Storm was the first space-based war. After that, the role of space strengthened in the Afghanistan war and the second Gulf War. The opponents didn't have any ability to deny the U.S. supremacy in space thus eliminating the need to conduct war in space itself. Information derived from the C4ISR systems and situational awareness were decisive factors in fighting for information superiority. Consequently, information warfare had become a key component in all military operations.

After Operation Desert Storm the Secretary of Defense reported: "The support provided by space forces significantly reduces the fog, friction and uncertainty of warfare. Joint forces can rapidly see, hear, and exploit the environment when space forces are properly integrated into the joint plan. This results in an improved situational awareness, a reduced response time, and a considerably more transparent battlespace, which provides the Joint Force Command (JFC) with dominant battlespace awareness."

Space has developed into an important element of information operations, which can be seen in a very close connection between space-based operations and information operations. Therefore, U.S. Space Command has gained more powerful role also in information warfare.

Lieutenant General Frank G. Klotz, Vice Commander Air Force Space Command, said in his speech in the Second International Conference on Space Research, Fisher Brothers Institute for Air and Space, Strategic Studies, Tel Aviv, Israel, on January 31, 2007: "I hasten to add, however, that the United States Air Force's role in space is just one part of a larger whole. That larger whole being something we refer to as the National Space Enterprise. It is comprised of many other organizations, including, for example, the National Reconnaissance Office, or NRO, and the National Aeronautics and Space Administration, or NASA. And, although the United States Air Force has, by far, the largest share of personnel and budget dedicated to military space acquisition and operations, the Army and Navy also play important roles in space as do many of our research and development centers."

And we do so, as I mentioned at the outset, because space is becoming increasingly important to all aspects of not only American life but also to people around the globe. The information revolution that is now transforming both private activity and global commerce depends to a very large extent on communications, remote sensing, navigation and precision timing, and weather satellites.

Our national leaders recognize this fact and the vital role space plays in the conduct of modern military operations. Starting with Desert Storm in the early 1990s, and continuing with Operation Enduring Freedom (in Afghanistan) and Operation Iraqi Freedom, combat at or near the Earth's surface has become increasingly reliant upon the so-called "high ground" of space. Let me offer some illustrative examples:

Reconnaissance satellites assisted the targeting of enemy forces and helped assess the effects of the air and ground campaign.

Early-warning satellites detected the launch of enemy missiles and alerted missile defense batteries. They also played an important role in warning civilian populations of impending attacks.

The vast majority of all the long distance communications used by the American and Allied forces were routed through space, including both commercial and military communication satellites. With ever-increasing

bandwidth, the most up-to-date intelligence information was sent to troops on the ground and pilots in their cockpits for nearly real-time strikes on sensitive, fleeting targets.

Weather satellites helped forecast conditions that could impact military operations, such as rainstorms that would obscure targets from aircraft or cause tanks to get bogged down in the desert sand.

The first critical component of that protection is space situational awareness (SSA). Currently, in Air Force Space Command we catalog approximately 14,000 objects in space but it's just that: a catalog. While we can detect objects as small as a baseball in a low Earth orbit or as small as a basketball in a geosynchronous orbit, we need more than just the location and general direction of an object. Our aim is to move beyond cataloging to understanding what is "up there."

To further advance our ability to support our field commanders, we are pursuing this space command and control architecture with an interdependent, net-centric mindset, realizing we must be able to adapt to the future environment. To operate in this dynamic tasking environment where we must be interconnected with the Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) systems, other space systems, the U.S. and Allied forces at every echelon in every corner of the globe, we must also continue to recapitalize our aging space constellations."

Battlespace awareness will be gained through space-based intelligence gathered in all spectra to turn battlespace awareness into knowledge. Battlespace awareness also includes information warfare. In a world heavily reliant on satellite communications, space will be a critical battlefield in any enemy's information war. Enhanced C4I will rely on space technology to identify important targets, handle data provided by the expansion of sensors, and transfer information to the weapons or forces best suited for the engagement. Precision engagement will invariably be dependent upon enhanced satellite global positioning data; space assisted targeting capabilities, and satellite communications to tell the shooter where to put bombs on target. This type of war-fighting framework will heavily rely on space capabilities. Any nation wishing to defend itself against a powerful military opponent will have to try to deny the enemy the use of space. It will have to destroy or paralyze the enemy's satellites or by information operation to deny the free use of electromagnetic spectrum on earth and space.

USAF Space Command sees the future very clear: "Space is at the very core of transforming the Armed Services' net-centric architectures including the Army's Future Combat System, Naval Fleet Communication and the Global Information Grid. Without space, these Service and DoD programs will simply be less effective." (USAF Space Command: Strategic Intent, www.afspc.af.mil)

The above-described evolution has an effect on the position of manned aircraft in the future. Space-based C4ISR, targeting and positioning systems now already reduce the need for strategic on-board systems. On an operational and strategic level unmanned air vehicles (UAVs) have been fielded. For example, in the Iraq war UAVs play an essential role in producing situational awareness for operational and strategic purposes. Space-to-surface weapons being developed reduce the need for conventional assault aircraft and bombers. It has been estimated that Lockheed Martin's F-35 Joint Strike Fighter may be the last manned fighter to be used in future operations.

The development and maintenance costs of space-based systems are so high that only for big powers or alliances (NATO) it is possible to build such systems. At present, the United States is the power having ability to weaponize space. Small countries like Finland can utilize the capability provided by space-based weapons systems by working in close cooperation with such powers; in other words, entering into an alliance. This is the only way to obtain the use of new capabilities. To be left beyond the development and use of space-based weapons systems leads to an increasing insufficiency of capabilities in such extent which may diminish a credible defense capability.

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